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PROGRESS REPORT ON IMPACT: MEASURING SPRUCE BEETLE DAMAGE IN THE WHITE MOUNTAINS OF ARIZONA

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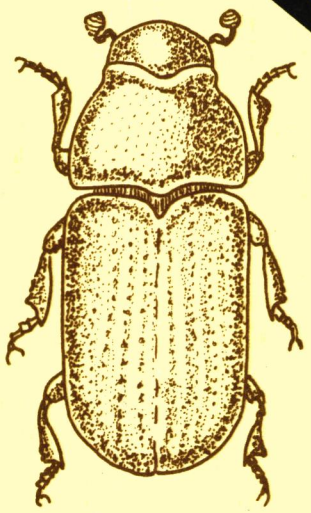

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PROGRESS REPORT ON IMPACT: MEASURING SPRUCE BEETLE DAMAGE IN THE WHITE MOUNTAINS OF ARIZONA

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INTRODUCTION

Recurrent infestations of the spruce beetle, Dendroctonus rufipennis (Kirby), have occurred throughout the Rocky Mountains (1, 2, 3). These infestations have established this bark beetle as an important factor damaging Engelmann spruce, Picea engelmannii Parry (4).

The first reported spruce beetle outbreak occurred in the White Mountains of Arizona early in this century (5). Several infestations have occurred in these mountains since then. Between 1948 and 1953, an infestation killed an estimated 22 percent of the Engelmann spruce resource (6). The most recent infestation began in 1967 and lasted until 1973. This infestation was evaluated annually from 1967 to 1974 and damage surveys were conducted in certain portions of the infestation from 1969 to 1973 and again in 1975.

The report has the following objectives:

1. Document the survey techniques used to measure spruce beetle damage.

2. Update progress made on data collection for impact work on stand depletion.

3. Establish the basis for future impact work on stand development.

The information on stand depletion and development will be used to evaluate spruce beetle impact on timber resource management.

INFESTATION AREA

The infestation occurred in the White Mountains of east central Arizona (Fig. 1). These volcanic mountains form one of the prominent ranges on the Mogollon Plateau, with elevations reaching 11,403 feet at Mt. Baldy Peak. The spruce-fir forest type occupies about 45,000 acres above 9,000 feet. While Engelmann spruce occurs at higher elevations in pure stands, at lower elevations it mixes with blue spruce, Picea pungens Engelm., corkbark fir, Abies lasiocarpa var. glauca (Beissn.) Franco, and quaking aspen, Populus tremuloides Michx. The forest lies in nine major drainages: Becker, Bonito, Diamond, East Fork, Ord, Paradise, Reservation, Smith, and West Fork. The first eight drainages, covering about 38,000 acres, are on the Fort Apache Indian Reservation. West Fork drainage, with about 7,000 acres, comprises the Mt. Baldy Wilderness of the Apache-Sitgreaves National Forest. The White Mountain Apache Tribal Council also has set aside 7,000 acres of their forest in East Fork drainage as a Primitive Area, subject to periodic review by the Council.

1967-1974 SURVEY TECHNIQUES

The initial signs of a building spruce beetle outbreak were found in logging debris examined in Becker and Diamond Creek drainages in 1967 (7). The populations were confined to downed material where an average of 74 larvae per square foot of bark was counted in Becker Creek and 48 per square foot in Diamond Creek. A ground-check in October 1968 revealed that 40 standing green trees had become infested in Becker Creek adjacent to the cutting areas and 60 trees along the boundary between West Fork and Reservation Creek drainages where no cutting was done.

Evaluation surveys to quantify tree losses began in 1969 and continued each year through 1973. All drainages were surveyed at least twice during this period, except the lower portion of East Fork, which was never surveyed. The upper part of East Fork drainage was combined with Bonito drainage. The annual losses and acres surveyed each year for each drainage are shown in Table 1, Appendix.

The first survey was made during the fall of 1969 using $\frac{1}{2}$-chain-wide strips at 10-chain intervals in Becker and Reservation Creek drainages and included counts of trees infested in 1968 and 1969 (8, 9). The survey indicated a light infestation in Becker Creek and a sharply increasing infestation in Reservation Creek. A suppression program of salvage logging and green trap trees was recommended for Reservation Creek (9). The salvage logging was completed in 1971.

In 1970, surveys were conducted in all the major drainages (10, 11). One-tenth acre fixed plots were used at 2-chain intervals along lines spaced 10 chains apart. The counts of infested trees showed that the infestation had spread throughout the White Mountains and had intensified since the previous year. An integrated suppression program of salvage logging, green trap trees, and lethal cacodylic acid-treated trees was recommended for 1971 in Becker, Diamond, Ord, Paradise, Smith, and Reservation drainages (10).

During the first week of January 1971, record-cold temperatures of -40° F killed 88 percent of the spruce beetle larvae above the snow in standing trees in Becker, Ord, Paradise, Reservation, and Smith drainages (12). Larvae and hibernating adults below the snow level experienced only 15 and 28 percent mortality, respectively. These severe winter temperatures reduced the infestation to such an extent that the planned suppression program was canceled.

The 1971 survey in Diamond, Ord, Paradise, and Smith drainages provided an opportunity to obtain estimates of living and beetle-killed trees and stand densities per acre (13). Plots were taken at 5-chain intervals

along lines 10 chains apart. Trees were sampled on variable-radius plots using a 20 basal-area-factor (BAF). Changes in number of living trees per acre and diameter distributions for spruce, basal area per acre for host and non-host species, merchantable volumes, and tree species composition were also obtained. Bark samples from infested trees were collected for analysis of attack density and brood production.

The 1972 survey was made in the same drainages as the previous year, but only with half the sampling intensity (14). The variable-radius plot method was used with a 10 BAF. Only standing and wind-thrown trees infested during 1972 were measured.

The 1973 survey was conducted in Becker, Bonito, Ord, Paradise, and Smith drainages along survey coordinate lines established during previous surveys (15). Becker and Bonito drainages were surveyed exactly as during the 1971 survey and the other three drainages were surveyed just as they had been in 1972. In addition, attacked standing trees were classed as to whether they were partially or completely infested. No beetle population measurements were taken.

A limited evaluation survey was conducted in part of Bonito Creek drainage during October 1974. The spruce beetle population was found to be at a very low level. Only a few 1974-infested spruce were found and most of these had been partially infested previous to 1974.

The greatest amount of tree mortality attributable to the latest spruce beetle infestation was found in Reservation, West Fork, Bonito, and Paradise drainages (Table 1). Most of the tree mortality occurred during 1969 and 1970. Little additional tree mortality was measured after the severe winter temperatures of 1971.

1975 SURVEY TECHNIQUES

The previous surveys provided only a general indication of spruce beetle damage for each drainage, since survey techniques differed each year. A more accurate measure of spruce beetle damage was considered necessary for impact work on stand depletion and recovery. To meet this need, tree mortality had to be measured with a specified error in an undisturbed area where the spruce beetle caused the greatest tree losses. The maximum effect of the spruce beetle on the tree resource can be determined by this approach. Taking measurements in an area, which will remain undisturbed, is a prerequisite for planned future work on stand development following this infestation.

SURVEY AREAS

The following criteria have been used to locate survey tracts:

1. Greatest tree losses - the drainages where the latest spruce beetle infestation caused the greatest tree losses. Reservation, Bonito, Paradise, and West Fork drainages met this criterion.

2. Undisturbed stands - the drainages which had not been logged. Only Bonito and West Fork drainages met this criterion, since they are in Wilderness and Primitive Areas, respectively.

3. Natural areas - the drainages which will remain undisturbed. Both West Fork and Bonito drainages met this criterion. Bonito is part of a Primitive Area designated by the White Mountain Apache Tribal Council, and West Fork has been formally designated as part of the National Wilderness Preservation System under the Wilderness Act of 1964 (P.L. 88-577).

Bonito. This drainage lies south of Mt. Baldy (Fig. 1 and 2). Bonito Creek flows southward and converges with several other small tributaries to form Big Bonito Creek, which eventually joins the Black River. Bonito drainage lies within the Primitive Areas of the Fort Apache Indian Reservation which is administered by the Bureau of Indian Affairs, Phoenix Area Office. The drainage was reached along the Salthouse Trail from logging roads in Reservation drainage. The 1973 survey (15) indicated the greatest spruce losses (16% of the trees and 28% of the basal area per acre) were in upper Bonito drainage (Fig. 4) between Bonito Cienega and Mt. Baldy to the north. A 300-acre rectangular tract was surveyed there.

West Fork. This drainage lies northeast of Mt. Baldy (Fig. 1 and 3). West Fork is the headwaters of the Little Colorado River. West Fork drainage lies in the Mt. Baldy Wilderness which is administered by the Springerville Ranger District of the Apache-Sitgreaves National Forest. The assessment area was reached along the West Fork trail from Sheep Crossing.

The 1970 evaluation survey (11) showed that most of the spruce mortality occurred in upper West Fork drainage between the Little Colorado River and Wilderness boundary to the south. A 300-acre rectangular tract was surveyed there in portions of sections 12 and 13, T6N, R26E, and sections 7 and 18, T6N, R27E.

DATA COLLECTION

Sample Size. The variability in number of beetle-killed trees per acre in upper Bonito drainage was used to determine the number of plots required in each assessment area to estimate the mean with 20 percent error limit, E (where E = t (α, n), Sx). Survey data collected in 1973 were used to determine this variability. Total spruce mortality attributed to the 1968-1973 spruce beetle infestation averaged 38.3 $\pm$ 7.2 trees per acre. Given this variability in spruce mortality from 158 observations, 140 plots needed to be sampled in Bonito drainage to have an error limit of 20 percent of the mean. It was assumed that the same sampling intensity would be required in West Fork, since total spruce mortality was comparable (Table 1, Appendix). However, only 120 plots were sampled because of time and money constraints. This sample size still gave acceptable error limit of 22 percent.

Survey Procedures. Each 300-acre tract was systematically surveyed with permanent plot centers spaced on a 5X5-chain grid.

Two concentric plots were established at each center: a small fixed-radius plot for regeneration and a variable-radius plot for larger trees. The 1/100-acre, fixed-radius plot (11.8 ft. radius) was used for seedlings and saplings (trees less than 5.0 inches d.b.h.). Only the number of seedlings and saplings were recorded. Trees greater than 5.0 inches d.b.h. were sampled on a variable-radius plot using a 20 BAF. A Spiegel-Relaskop was used to measure the critical angle from each plot center. Each plot center was marked with a one square inch redwood stake, painted fluorescent orange and numbered with a metal tag. The d.b.h. of each standing tree on plot was measured to the nearest 1-inch class (e.g., 5-inch class = 5.0-5.9; 6-inch class = 6.0-6.9; etc.). The species of each tree was recorded, and Engelmann spruce was further classed as either living or killed by the recent spruce beetle infestation. The presence of bark with old beetle galleries, emergence holes, and small twigs in the dead crown was used to separate recently killed trees from older snags without bark. Partially attacked trees with green crowns were considered as live trees. The tree measurement data were tallied on a form designed for use with the NSEC computer program.

The survey tracts were checked for two important Engelmann spruce diseases--western spruce dwarf mistletoe, Arceuthobium microcarpum (Engelm.) Hawksworth and Wiens, and spruce broom rust, Chrysomyxa arctostaphyli Diet. Both pathogens cause tree growth loss and mortality, and knowledge of their abundance was considered essential to accurately project stand development following the spruce beetle infestation. The incidence of western spruce dwarf mistletoe in portions of the White Mountains was evaluated recently (16) and found

to be rare above 10,000 feet. No comparable information is available for spruce broom rust. The presence of dwarf mistletoe was recorded if the aerial shoots or associated witches' brooms were visible on trees within the plot. Dwarf mistletoe brooms are small and dense (17) and easily distinguished from those formed by broom rust, which are large and yellowish during the summer (18).

DATA ANALYSES

Tree measurement and classification data were analyzed by the NSEC computer program. Diameter distributions for pole and sawtimber trees of each species and damage class for spruce in numbers and basal areas per acre were calculated. Totals for regeneration and for the remaining trees in each species and damage class were analyzed statistically.

The incidence of dwarf mistletoe and broom rust was determined as a percent of the plots on which each pathogen was found.

RESULTS

Stand tables for each survey tract have been presented in Appendix Tables 2 through 5. These have been summarized in the following sections.

BONITO DRAINAGE

Regeneration. Engelmann spruce and/or subalpine fir regeneration were present in this area on 92.5 percent of the plots. Spruce seedlings and saplings averaged 964 ± 86 trees per acre, while those of fir averaged 322 ± 31 trees per acre.

Poles and Sawtimber. The stand tables for trees in this drainage (Appendix Tables 2 and 2) have been summarized by damage and size classes as follows:

Tree damage class	Total stand (No.)	Total spruce (No.)	Percent spruce by size class			
			Poles	Sawtimber		
			5"-11.9"	12"-15.9"	16"-19.9"	20"+
Live						
Trees/acre	222 ± 24	202 ± 21	65.1	22.2	9.5	3.3
Square feet/acre	143 ± 10	136 ± 10	31.9	32.2	23.0	12.8
Beetle-killed						
Trees/acre	39 ± 7	39 ± 7	21.1	22.8	28.6	27.4
Square feet/acre	63 ± 10	63 ± 10	6.1	14.5	29.4	50.0
Total						
Trees/acre	261 ± 24	241 ± 20	57.9	22.3	12.7	7.2
Square feet/acre	206 ± 11	199 ± 13	23.7	26.6	25.0	24.6

Pathogens. No spruce dwarf mistletoe nor broom rust were found on any of the plots in this area.

WEST FORK DRAINAGE

Regeneration. Engelmann spruce and/or subalpine regeneration occurred on 97.5 percent of the plots in this area. Spruce regeneration averaged 752 ± 61 trees per acre and fir averaged 761 ± 57 trees per acre.

Poles and Sawtimber. Stand tables for trees in this drainage (Appendix Tables 4 and 5) were summarized by tree damage and size class as follows:

Tree damage class	Total stand (No.)	Total spruce (No.)	Percent spruce by size class			
			Poles	Sawtimber		
			5"-11.9"	12"-15.9"	16"-19.9"	20"+
Live						
Trees/acre	276 ± 29	181 ± 23	68.3	21.0	8.0	2.6
Square feet/acre	162 ± 10	112 ± 10	34.5	32.8	21.3	11.2
Beetle-killed						
Trees/acre	19 ± 6	19 ± 6	30.8	19.2	23.2	16.6
Square feet/acre	24 ± 7	24 ± 7	13.9	16.0	31.3	38.9
Total						
Trees/acre	295 ± 29	200 ± 23	65.7	20.8	9.5	4.0
Square feet/acre	186 ± 11	136 ± 13	30.8	29.8	23.1	16.1

Pathogens. Spruce dwarf mistletoe was found on only 3 percent of the plots in this area. Spruce broom rust was not found on any of the plots.

DISCUSSION

The spruce beetle infestation had a greater affect on the spruce resource in Bonito drainage than in West Fork. Before the infestation, Bonito averaged 241 ± 20 spruce poles and sawtimber trees per acre, with 199 ± 13 square feet of basal area. The spruce beetle killed 16 percent of the trees and 32 percent of the basal area. West Fork, on the other hand, averaged 200 ± 23 spruce poles and sawtimber trees per acre, with 136 ± 13 square feet per acre. These losses amounted to 10 percent of the trees and 18 percent of the basal area.

The spruce mortality was measured within the specified error limit of 22 percent only in Bonito drainage. There the estimated mean number of beetle-killed trees was 39 ± 7, giving an error limit of 18 percent. In West Fork drainage, the mean number of beetle-killed trees was 19 ± 6, giving an error limit of 32 percent. Spruce mortality in Bonito drainage also was less variable than in West Fork. The

coefficient of variation for the mean number of beetle-killed trees was 99 percent in Bonito, whereas it was 164 percent in West Fork.

The larger size classes in each drainage sustained the greatest tree and basal area losses. Tree and basal area mortalities in large trees (16"+ diameter) amounted to 56 and 79 percent in Bonito drainage and 40 and 70 percent in West Fork.

The infestation had only a minimal affect on the species composition of poles and sawtimber-sized trees (expressed in terms of basal area per acre) in the surveyed areas. The spruce component in Bonito drainage dropped from 97 percent to 95 percent and in West Fork from 73 percent to 69 percent.

Spruce regeneration was well above the minimum stocking levels for uncut stands (19) in each surveyed area. Spruce comprised 75 percent of the stems in Bonito and 50 percent of those in West Fork.

Spruce pathogens were scarce in the surveyed portions of each drainage. Spruce broom rust was absent and spruce dwarf mistletoe was rare.

CONCLUSIONS

The 1967-1973 spruce beetle infestation in the White Mountains caused the greatest spruce mortality in Bonito drainage, where about one-third of the stand was killed. West Fork drainage experienced less spruce mortality, as only about 20 percent of the stand was killed. The severity of tree-killing in both areas resulted from stand characteristics considered to favor outbreaks (20, 21).

The spruce mortality was measured within the specified error limit of 20 percent only in Bonito drainage. An error limit of 32 percent in West Fork resulted from a greater variability in tree mortality than had been expected. The error limit probably would have been within the specified level if the survey area had been located at higher elevations, where subsequent observation revealed there were substantially more beetle-killed trees.

The live spruce stands in both surveyed areas were reduced by the infestation to a less susceptible condition. However, the potential for limited future tree mortality from epidemic populations still remains within localized portions of each drainage. This potential will increase as the stands develop spruce basal areas in excess of 150 square feet per acre (20, 21). The time required to achieve this basal area level is unknown, but could be as short as 20 years, given a diameter growth response in poles and small sawtimber trees of 1 inch per 10 years, starting basal areas of 112 to 136 square feet per acre, and a predominance of spruce in all size classes. The

established regeneration, which exceeds the minimum stocking requirements in both drainages, should also respond to release and contribute basal area ingrowth to maintain spruce in the smaller size classes. Each surveyed area should be examined periodically to obtain a more complete understanding of stand development following the observed levels of spruce mortality.

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A P P E N D I X

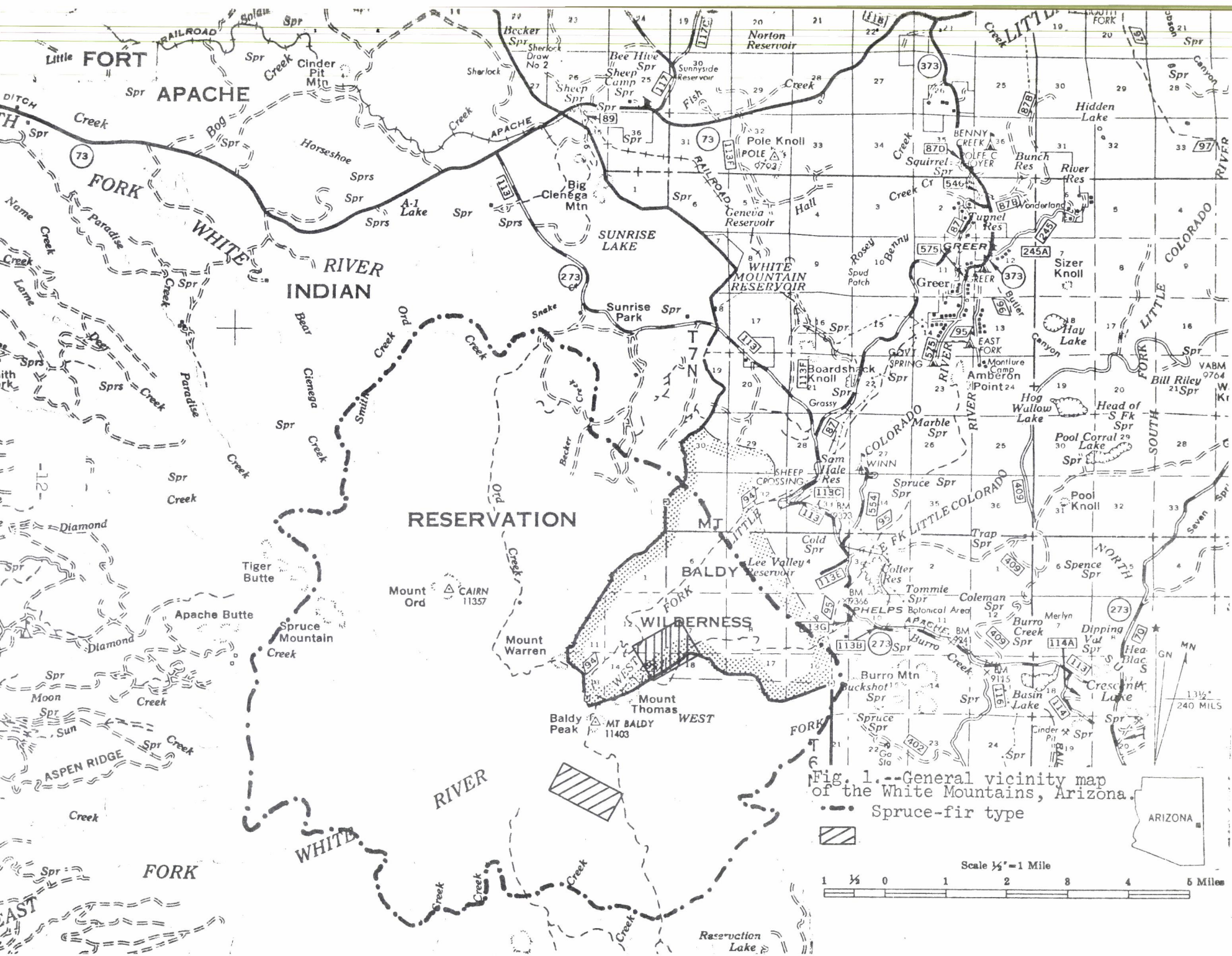

Fig. 1.--General vicinity map of the White Mountains, Arizona.
Spruce-fir type

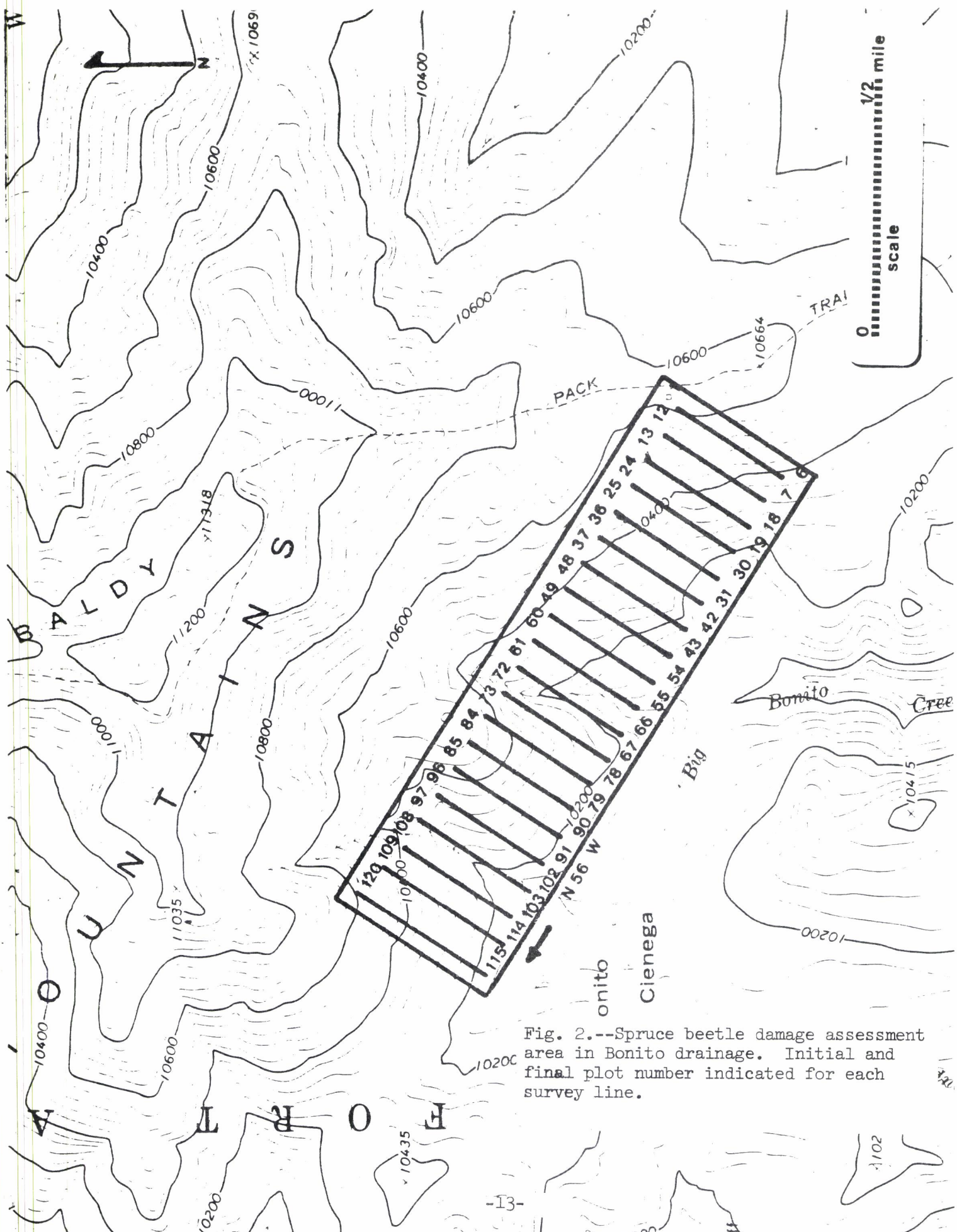

Fig. 2.--Spruce beetle damage assessment area in Bonito drainage. Initial and final plot number indicated for each survey line.

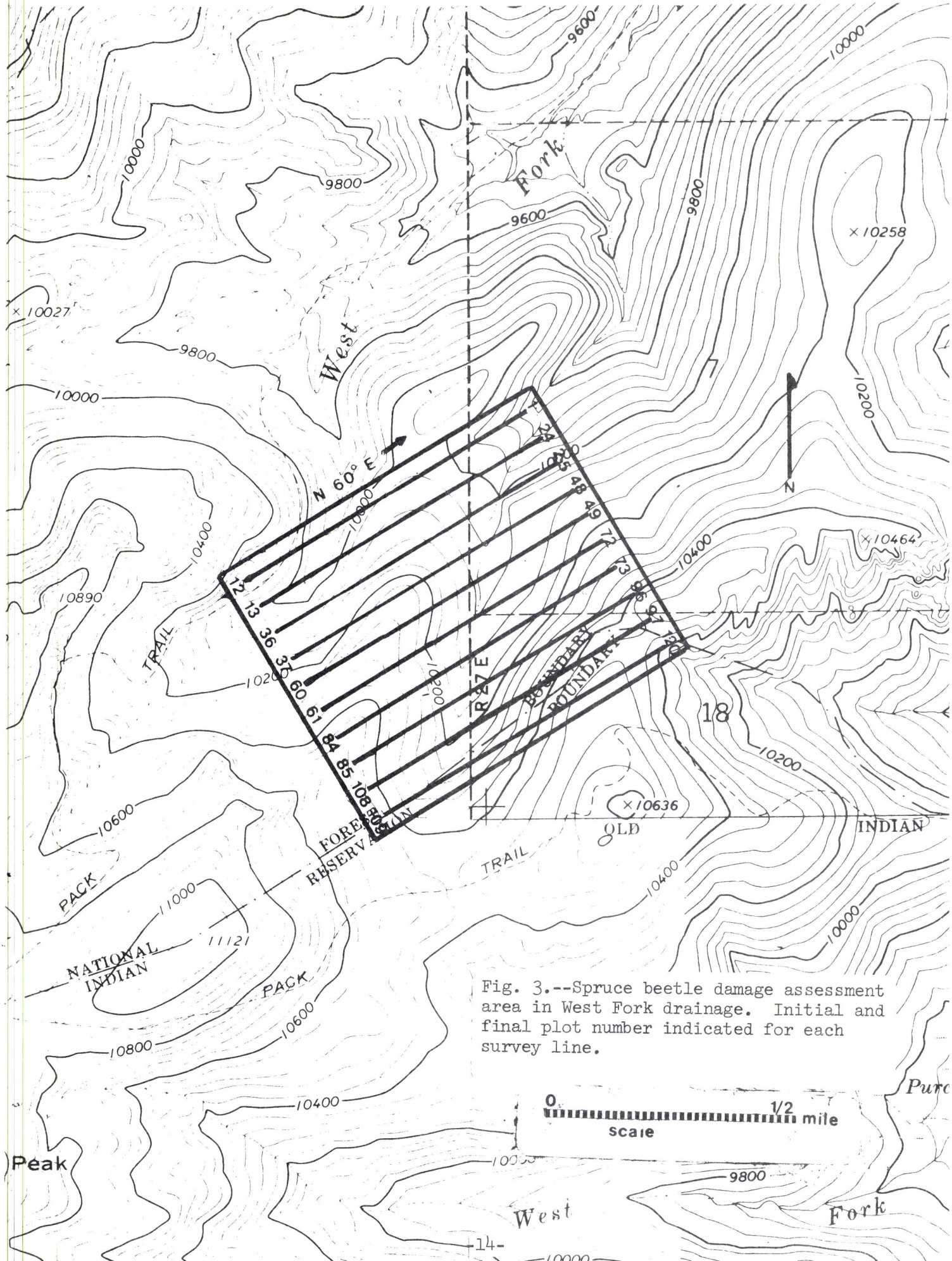

Fig. 3.--Spruce beetle damage assessment area in West Fork drainage. Initial and final plot number indicated for each survey line.

Fig. 4.--Engelmann spruce mortality from 1968-1973 spruce beetle infestation in upper Bonito drainage, White Mountain Apache Tribal Wilderness, White Mountains, Arizona.

Table 1.--Estimates of annual spruce mortality from spruce beetle infestation, 1968-1973, White Mountains, Arizona.

Drainage	Year of infestation						Cumulative total I/T/A
	1968[10,11]	1969[12,13]	1970[12,13]	1971[15]	1972[16]	1973[17]	
Becker							
I/T/A	.8	1.83	4.79	--	--	.45	7.84
A/S	1,716	4,663	4,663	--	--	2,700	
Bonito							
I/T/A	--	4.25	8.2	--	--	2.08	14.53
A/S	--	6,636	6,636	--	--	3,740	
Diamond							
I/T/A	--	3.80	1.14	.7	.06	--	5.64
A/S	--	3,565	3,565	2,985	2,985	--	
Ord							
I/T/A	--	.91	5.87	1.98	.7	.53	9.29
A/S	--	4,709	4,709	4,685	4,685	4,770	
Paradise							
I/T/A	--	4.15	5.37	4.16	.61	.22	13.90
A/S	--	5,754	5,754	4,540	4,540	4,340	
Reservation							
I/T/A	1.24	3.96	15.20	.24	--	--	20.64
A/S	4,556	5,637	5,637	695	--	--	
Smith							
I/T/A	--	1.74	4.52	1.77	.45	.03	8.06
A/S	--	2,798	2,798	2,755	2,755	2,810	
West Fork							
I/T/A	--	3.42	15.55	--	--	--	18.97
A/S	--	2,746	2,746	--	--	--	
Avg. I/T/A	1.12	3.15	7.68	2.25	.50	.68	
Total A/S	6,272	36,508	36,508	15,660	14,965	18,360	

Abbreviations: I/T/A = Infested trees per acre
A/S = Acres surveyed

Table 2.--Stand table for Engelmann spruce in Bonito drainage - 300 acres.

D.b.h. (1-inch classes)	Engelmann spruce trees per acre					
	Live		Beetle-killed		Total	
	Number	Square feet	Number	Square feet	Number	Square feet
5	33.0	4.5	0	0	33.0	4.5
6	20.4	4.0	0	0	20.4	4.0
7	13.1	3.5	1.9	0.5	15.0	4.0
8	19.1	6.7	1.0	0.3	20.1	7.0
9	17.7	7.8	2.3	1.0	20.0	8.8
10	15.9	8.7	1.2	0.7	17.1	9.4
11	12.1	8.0	2.0	1.3	14.1	9.3
12	11.5	9.0	1.9	1.5	13.4	10.5
13	14.3	13.2	2.0	1.8	16.3	15.0
14	11.5	12.3	2.6	2.8	14.1	15.1
15	7.5	9.2	2.4	3.0	9.9	12.2
16	6.8	9.5	2.7	3.8	9.5	13.3
17	5.4	8.5	4.1	6.5	9.5	15.0
18	3.8	6.7	2.7	4.8	6.5	11.5
19	3.3	6.5	1.7	3.3	5.0	9.8
20	2.1	4.7	2.6	5.7	4.7	10.4
21	1.3	3.2	1.6	3.8	2.9	7.0
22	1.4	3.7	1.9	5.0	3.3	8.7
23	0.4	1.7	1.1	3.2	1.5	4.9
24	0.6	2.0	1.0	3.2	1.6	5.2
25	0.2	0.7	0.6	2.0	0.8	2.7
26	0.3	1.0	0.6	2.2	0.9	3.2
27	0.1	0.3	0.5	2.0	0.6	2.3
28	0.1	0.3	0.5	2.2	0.6	2.5
29	0.04	0.2	0.1	0.7	0.14	0.9
30	0.03	0.2	0.1	0.3	0.13	0.5
31	0	0	0.1	0.5	0.1	0.5
32	0	0	0.03	0.2	0.03	0.2
33	0	0	0	0	0	0
34	0	0	0.05	0.3	0.05	0.3
35	0	0	0.03	0.2	0.03	0.2
36	0	0	0	0	0	0
37	0	0	0.02	0.2	0.02	0.2
Total	201.97	136.1	39.33	63.0	241.30	199.1
Sample size	120	120	120	120	120	120
Standard deviation	116.2	57.3	39.0	53.1	109.3	69.3

Table 3.--Stand table for non-host species in Bonito drainage - 300 acres

D.b.h. (1-inch classes)	Trees per acre					
	Subalpine fir		Douglas-fir		Total	
	Number	Square feet	Number	Square feet	Number	Square feet
5	6.1	0.8	0	0	6.1	0.8
6	1.7	0.3	0	0	1.7	0.3
7	3.1	0.8	0	0	3.1	0.8
8	2.9	1.0	0	0	2.9	1.0
9	2.3	1.0	0	0	2.3	1.0
10	1.5	0.8	0	0	1.5	0.8
11	1.0	0.7	0	0	1.0	0.7
12	0.4	0.3	0	0	0.4	0.3
13	0	0	0	0	0	0
14	0.5	0.5	0	0	0.5	0.5
15	0.3	0.3	0	0	0.3	0.3
16	0.2	0.3	0	0	0.2	0.3
17	0.2	0.3	0	0	0.2	0.3
18	0	0	0.1	0.2	0.1	0.2
19	0.1	0.2	0	0	0.1	0.2
20	0	0	0	0	0	0
21	0	0	0	0	0	0
22	0	0	0.1	0.2	0.1	0.2
Total	20.3	7.3	0.2	0.4	20.5	7.7
Sample size	120	120	120	120	120	120
Standard deviation	57.4	16.8	1.2	2.6	57.3	16.9

Table 4.--Stand table for Engelmann spruce in West Fork drainage - 300 acres.

D.b.h. (1-inch classes)	Engelmann spruce trees per acre					
	Live		Beetle-killed		Total	
	Number	Square feet	Number	Square feet	Number	Square feet
5	34.2	4.7	0	0	34.2	4.7
6	20.4	4.0	0	0	20.4	4.0
7	15.0	4.0	2.5	0.7	17.5	4.7
8	13.4	4.7	1.9	0.7	15.3	5.4
9	12.1	5.3	0.4	0.2	12.5	5.5
10	14.7	8.0	2.1	1.2	16.8	9.2
11	11.9	7.8	1.0	0.7	12.9	8.5
12	11.9	9.3	1.1	0.8	13.0	10.1
13	11.5	10.7	0.2	0.2	11.7	10.9
14	6.5	7.0	1.4	1.5	7.9	8.5
15	7.9	9.7	1.1	1.3	9.0	11.0
16	4.3	6.0	1.2	1.7	5.5	7.7
17	4.4	7.0	1.2	1.8	5.6	8.8
18	2.9	5.2	1.1	2.0	4.0	7.2
19	2.9	5.7	1.0	2.0	3.9	7.7
20	1.5	3.3	0.4	0.8	1.9	4.1
21	1.0	2.5	0.8	2.0	1.8	4.5
22	0.6	1.5	0.8	2.0	1.4	3.5
23	0.8	2.2	0.4	1.2	1.2	3.4
24	0.3	1.0	0.2	0.7	0.5	1.7
25	0.3	1.2	0.2	0.7	0.5	1.9
26	0.1	0.5	0.2	0.7	0.3	1.2
27	0.1	0.3	0.2	0.7	0.3	1.0
28	0	0	0.04	0.2	0.04	0.2
29	0	0	0.04	0.2	0.04	0.2
30	0	0	0.03	0.2	0.03	0.2
31	0	0	0	0	0	0
32	0	0	0	0	0	0
33	0	0	0.03	0.2	0.03	0.2
Total	178.7	111.6	19.5	24.4	198.2	136.0
Sample size	120	120	120	120	120	120
Standard deviation	125.4	56.6	31.9	39.9	127.1	73.1

Table 5.--Stand table for non-host species in West Fork drainage - 300 acres

D.b.h. (1-inch classes)	Trees per acre					
	Subalpine fir		Aspen		Total	
	Number	Square feet	Number	Square feet	Number	Square feet
5	15.9	2.2	0	0	15.9	2.2
6	9.3	1.8	0.8	0.2	10.1	2.0
7	10.0	2.7	0	0	10.0	2.7
8	10.5	3.7	1.0	0.3	11.5	4.0
9	10.2	4.5	0	0	10.2	4.5
10	9.5	5.2	0.9	0.5	10.4	5.7
11	4.3	2.8	0.5	0.3	4.8	3.1
12	5.7	4.5	0.4	0.3	6.1	4.8
13	4.0	3.7	0.4	0.3	4.4	4.0
14	3.4	3.7	0.5	0.5	3.9	4.2
15	1.8	2.2	0.1	0.2	1.9	2.4
16	1.3	1.8	0.1	0.2	1.4	2.0
17	1.7	2.7	0	0	1.7	2.7
18	0.9	1.7	0.1	0.2	1.0	1.9
19	0.6	1.2	0	0	0.6	1.2
20	0.2	0.5	0.1	0.2	0.3	0.7
21	0.3	0.8	0.1	0.3	0.4	1.1
22	0.1	0.3	0	0	0.1	0.3
23	0	0	0.1	0.2	0.1	0.2
Total	89.7	46.0	5.1	3.7	94.8	49.7
Sample size	120	120	120	120	120	120
Standard deviation	105.6	40.6	18.1	12.7	107.2	42.8